

NASA's Johnson Space Center

# Semi-Autonomous Vehicle Project

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## Abstract & Project Overview

The primary objective this summer is “evaluating standards for wireless architecture for the internet of things”. The Internet of Things is the network of physical objects or “things” embedded with electronics,



software, sensors and network connectivity which enables these objects to collect and exchange data and make decisions based on said data. This was accomplished by creating a semi-autonomous vehicle that takes advantage of multiple sensors, cameras, and onboard computers and combined them with a mesh network which enabled communication across large distances with little to no interruption. The mesh network took advantage of what is known as DTN – Disruption Tolerant Networking which according to NASA is the new communications protocol that is “the first step towards interplanetary internet.” The use of DTN comes from the fact that it will store information if an interruption in communications is detected and even forward that information via other relays within range so that the data is not lost. This translates well into the project because as the car moves further away from whatever is sending it commands (in this case a joystick), the information can still be forwarded to the car with little to no loss of information thanks to the mesh nodes around the driving area.

## Internet of Things Background

The idea of having a smart network of devices and exchanging data between them has been around since the early 1980's and the very first internet connected appliance happened in 1982 with a coke machine that was able to report information about its current inventory and temperature. There are a multitude of possibilities that could benefit mankind as a whole and increase our overall technological advancement, some ideas are listed in the table below:

Self-driving Cars	o The self-driving car, as it is thought today, will need a multitude of sensors and cameras and the ability to communicate with other vehicles nearby
Intelligent Power Grid	o Smart grid that is able to detect and even predict changes in demand based off of weather information, holiday and celebration dates, etc., or anything that can contribute to a fluctuation in overall power needs
Automated Waste Disposal	o Smart bins that would be able to track their capacity which would allow for more efficient use of time in picking up only the containers that are deemed full. Additionally, type of material could be analyzed and even separated for recycle or refuse
Smart Homes and Appliances	o Automated thermostats that receive information from weather stations and can adjust as necessary o Automatic incident reporting such as break-ins, or home/appliance maintenance

There are millions of applications to the Internet of Things, many of which will play a role in human spaceflight and space exploration which is of particular importance to NASA.

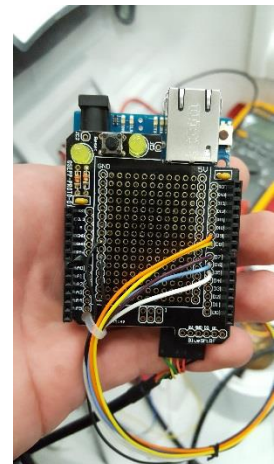
## Project Duties

The semi-autonomous vehicle project combines mechanical design, shop skills, programming, web development, wired and wireless networking, as well as 3D printing. Since I was the only intern tasked with this project I had responsibility over every aspect of the vehicle and wound up facing a lot of challenges that were fundamental to the understanding of modern robotics. Each

of the challenges faced taught me something and gave me some small sense of accomplishment each time a particular obstacle was overcome.

## Major Accomplishments & Challenges Faced

Being an international business graduate and studying to be a mechanical engineer I found myself in a world of electrical engineering and computer programming when I got involved with the project. Little by little I was learning how to do things I had very little prior experience with and began to see the involved when trying to get these to work together. Firstly, the Arduino Ethernet board, our first choice for controlling the steering and drive motors, was not actually compatible with the Servo library which was being used to move the motors. This was not originally recognized until nearly 75% of the way through the project. The solution was to utilize a different Arduino, Arduino YUN, which required a significant change in the vehicle's operating code.



## Results of Semi-autonomous Vehicle Project & Future Ideas

As it stands, the vehicle is able to drive via a wireless joystick in the hands of a person. It is fitted with multiple sensors including sonar that is able to detect obstacles, maneuver and limit speed accordingly if an obstacle is detected. It is also outfitted with a camera which streams live video to a webpage that is displayed on the Android while driving. The next step is to have the vehicle be able to detect when communications are lost and work on reacquiring signal to those in control of driving it. An additional step, which may serve as another internship project, is to outfit the vehicle with more automation and sensors. The majority of the requirements are

already apart of the vehicle and would just need to be modified or added to in order to achieve full autonomy. Additionally, it may be useful to utilize the IMU (Inertial Measurement Unit) that has been attached to the vehicle to help with navigation and detect changes in elevation.

## Overall Experience and Personal Impact

My experience at Johnson Space Center this summer has been incredible. I've had the opportunity to see some amazing things and meet some amazing people. The intern project has taught me a lot about robotics as a whole, as well as many technical skills that would have been more challenging to develop without significant personal resources. NASA, and by extension my mentor Chatwin Lansdowne, have provided a very useful and beneficial learning environment and it has only strengthened my resolve to become a full employee.

Keywords: Self-driving, semi-autonomous, Internet of Things (IoT), DTN – Disruption/Delay tolerant Networking, communications, Arduino, Raspberry Pi, webserver